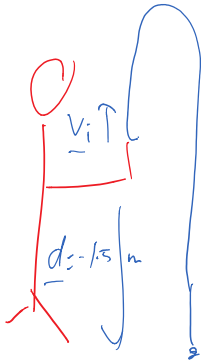
Vectors - adding/subtract vectors in 2 dimensions

Q44 p-40



↑ +

$t = 2.0\ s$

$a = -9.80\ m/s^2$

$d = V_i t + \frac{1}{2} a t^2$

$-1.5\ m = V_i (2.0\ s) + \frac{1}{2}(-9.80\ m/s^2)(2.0\ s)^2$

$-1.5 = 2 V_i - 19.6$

$19.6 = 2 V_i$

$19.1 = 2 V_i$

$V_i = 9.05\ m/s$

$9.6\ m/s$

Q57

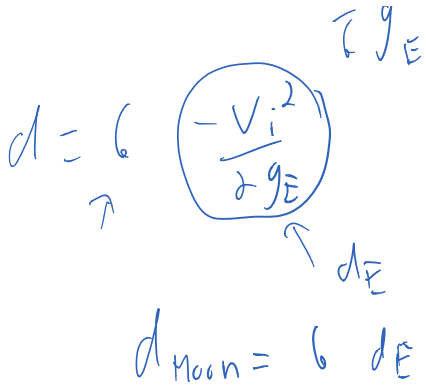
V_i, $a = \frac{1}{6} g_E$, d, $V_f = 0$

$V_f^2 = V_i^2 + 2ad$

$0 = V_i^2 + 2ad$

$d = \frac{-V_i^2}{2a} = \frac{-V_i^2}{2(\frac{1}{6} g_E)}$

$\frac{1}{6} g_E$



$d_{Moon} = 6\, d_E$

Vectors

- quantity with magnitude and direction
eg. displacement, velocity, acceleration,
xxxxx Force xxxxxx momentum xxxxxx

scalar - quantity with only magnitude
eg. speed, distance, time, temperature, energy, work, power, mass,

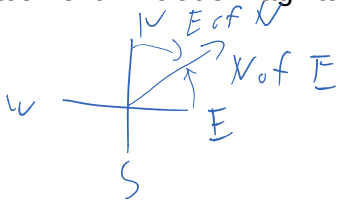
vectors can be represented by an arrow, with the length representing the magnitude.

add vectors - draw them head to tail

subtract vectors - flip the direction of the second vector

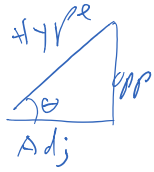
eg. you walk 4.0 km due East, then 3.0 km North in 2.0 hours.

determine
a) distance travelled
b) displacement - include magnitude and direction



c) give the average speed and average velocity

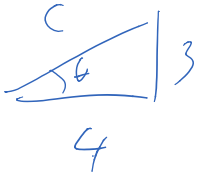
SOHCAHTOA
SINE OPPOSITE OVER HYPOTENUSE
COSINE ADJACENT OVER HYPOTENUSE
TANGENT OPPOSITE OVER ADJACENT



TANGENT OPPOSITE OVER ADJACENT

Pythagorus
$a^2 + b^2 = c^2$

A) 7.0 KM



$9 + 16 = 25$

$\sqrt{25} = 5$

$\tan\theta = 3/4$

$\theta = \tan^{-1} 3/4$

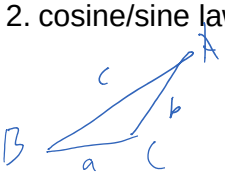
$= 37°$

b) 5.0 km 37 degrees North of East (or 53 degrees East of North)

What if the angle is not 90 degrees?

3 methods:

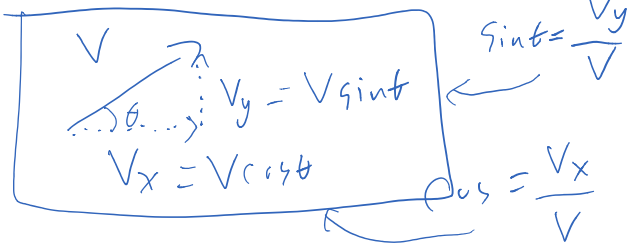
1. scale vector addition diagram with protractor and ruler.
2. cosine/sine law

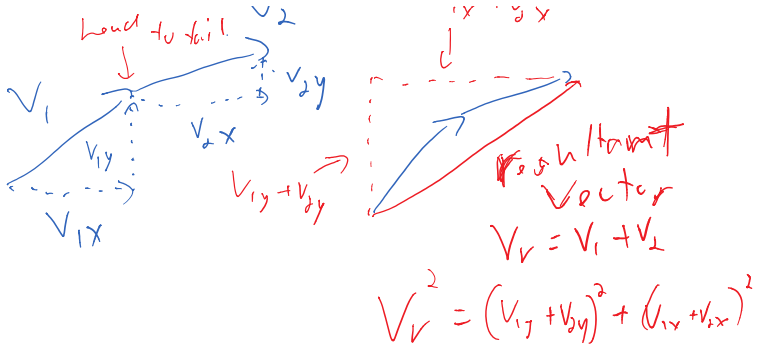


$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

$a^2 = b^2 + c^2 - 2bc\cos A$

3. vector components - any vector can be represented as the sum of two perpendicular vectors, called vector components.

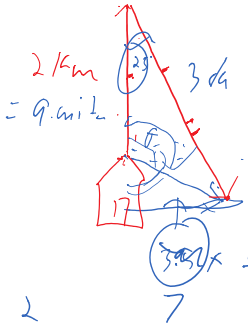




eg. Solve the following problem using the 3 methods above:
You start 2.0 km North of the school and walk 3.0 km at 25.0 degrees East of South.

a) determine your final position

b) subtract your displacement vector from your initial position to determine a new final position.



Scale 2km = 9 units

$\frac{2\text{km}}{9\text{units}} = 0.76\text{km}$? 26° S of E

1.5 km 62° E of S

$X_r^2 = 3^2 + 2^2 - 2(2)(3)(\cos 25°)$

$X_r = 1.4575\text{ km}$

$X_r = 1.5\text{km}$

$\frac{\sin\theta}{3} = \frac{\sin 25°}{1.4575}$

$\theta = 60.44° - \text{E of South}$

$120° \text{ E of North}$

Components

Vector 1 $V_{N_1} = 2.0\,km$ North

$V_{E_1} = 0\,km$ East

Vector 2

$V_N = 3km \cos 25°$

$= 2.72\,km$

Negative

$V_E = 3.0km \sin 25°$

$= 1.2679\,km$

Vector total

$V_N = V_{N1} + V_{N2} = 2.0km + (-2.721km)$

$= -0.721\,km$

$V_E = V_{E_1} + V_{E_2} = 0 + 1.2679km$

$V_E = 1.2679km$

$V_R = \sqrt{0.721^2 + 1.2679^2}$

$= 1.4579\,km$

$= 1.5\,km$

direction 0.721 ←

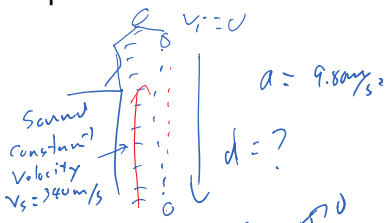
$\theta = 29.62°$

$\approx 30°$ S of E

Assignment
p60-61,
q1, 5, 9, 11, 15, 17
read labbook investigation 3
method 2 p34-36

Block 2-3
Questions from Homework
Vector addition
assginement
p60-61,
q1, 5, 9, 11, 15, 17
read labbook investigation 3
method 2 p34-36

p40 q43



$d = \frac{1}{2} a t^2$

$t_{down} = \sqrt{\frac{2d}{a}}$

$t_{up} = \frac{d}{v_s}$

$t = t_{down} + t_{up} = 3.0 s$

$\sqrt{\frac{2d}{a}} + \frac{d}{v_s} = 3.0 s$

$\sqrt{\frac{2d}{a}} = \left(3.0 - \frac{d}{v_s}\right)$

$\frac{2d}{a} = 9 - 2(3)\frac{d}{v_s} + \frac{d^2}{v_s^2}$

$0 = 9 - \left(\frac{6}{v_s} + \frac{2}{a}\right)d + \frac{d^2}{v_s^2}$

$0 = 340^2(9) - 340\left(\frac{6}{340} + \frac{2}{9.8}\right)d + d^2$

$0 = 1046400 - 75.39d + d^2$

$d = +75.39 \pm \sqrt{75.39^2 - 4(1046400)}$

OV

$d = \frac{1}{2}at^2$

$d = (3-t)340$

$\frac{1}{2}at^2 = (3-t)340$

$4.9t^2 + 340t - 1020 = 0$

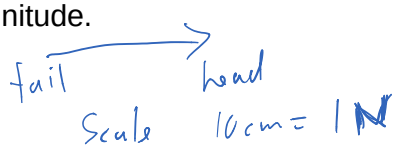
$-340 \pm \sqrt{340^2 - 4(4.9)(-1020)}$ / $2(4.9)$

-340 ± 368.228 / 9.8

$\frac{28.228}{9.8}$ $t = 2.88s$

$d = 4.9(2.88)^2 = \boxed{41m}$

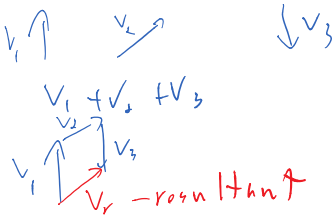
vectors
what are vectors?
Quantities with magnitude and direction.
Show on a diagram as an arrow, with length representing magnitude.



What are some vectors quantities?
Force and momentum are the key vectors to remember.
velocity, acceleration, displacement,

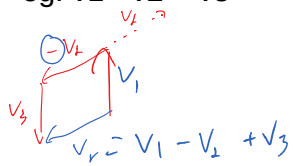
Scalars - magnitude only
eg. mass, work, energy, distance, speed, time(?), temperature, pressure,

vector addition - draw the vectors head to tail in a vector addition diagram. The resultant vector is from start of the first vector to the end of the last vector.



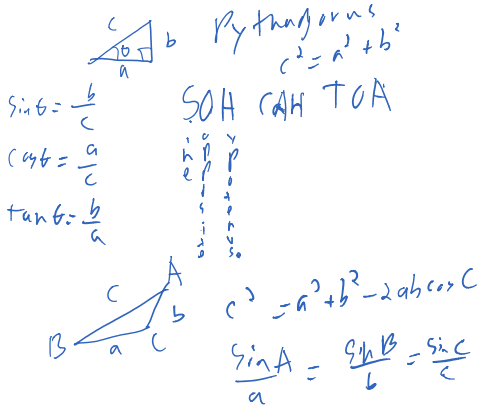
Vector subtraction- reverse the direction of the subtracted

vector
eg. v1 - v2 + v3

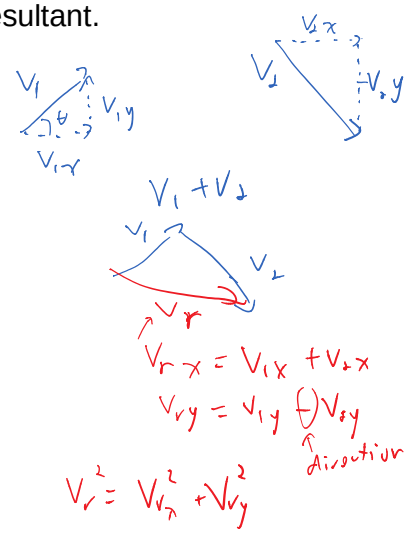


to determine the magnitude of the resultant vector we solve in 3 methods:

1. scale vector diagram, using a ruler and protractor
2. for two vectors, use cosine law and sine law

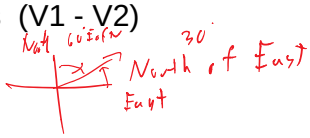


method 3
Each vector can be represented as the sum of two perpendicular vectors - called vector components.
by summing all the components, you get the components of the resultant.



eg. 1. you walk 3.0 km East then 4.0 km North.
Determine
a) distance travelled
b) resultant displacement (magnitude and direction)

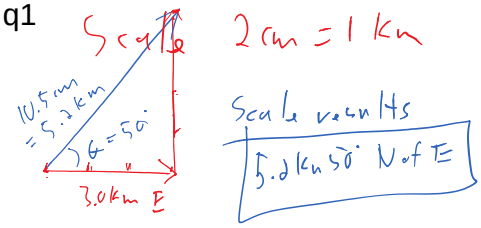
c) difference between the two vectors (V1 - V2)



2. You walk 3.0 km East then 4.0 km 25.0 degrees South of East. Determine the magnitude and direction of the resultant displacement using 1. scale diagram 2. cosine/sine law 3. vector components

p60-61,
q1, 5, 9, 11, 15, 17
read labbook investigation 3 method 2 p34-36

q1



Pythagorus

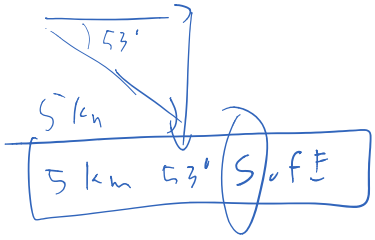
$a^2 + b^2 = c^2$ $c = 5.0$ km

$3^2 + 4^2 = c^2$

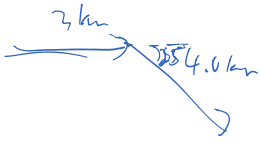
$\tan\theta = \frac{4}{3}$ $\theta = \tan^{-1}\frac{4}{3}$

$\theta = 53°$

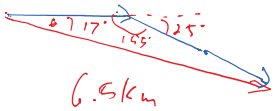
5.0 km 53° N of E



Part 2



1.



2. $c^2 = 3^2 + 4^2 - 2(3)(4)\cos 155°$

$c = 6.84$ km

$\frac{\sin\theta}{4} = \frac{\sin 155}{6.84}$

$\theta = 14°$

6.8 km 14° S of E

Method 3

V_1 components $V_{1E} = 3.0$ km

$V_{1N} = 0$

V_2 components $V_{2E} = 4\cos 25 = 3.625$

$V_{2S} = 4\sin 25 = 1.69$

$V_{1E} + V_{2E} = 3 + 3.625 = 6.625$

$V_{1S} + V_{2S} = 0 + 1.69 = 1.69$

$V_r = \sqrt{6.625^2 + 1.69^2}$

$V_r = 6.8$ km

$\theta = \tan^{-1}\frac{1.69}{6.625} = 14°$

6.8 km 14° S of E

Vectors - Chapter 3

vectors are quantity with both magnitude and direction.

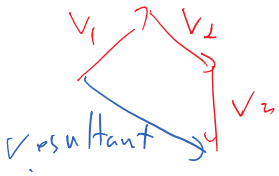
Can be represented by an arrow with length corresponding to the magnitude.

eg. velocity, acceleration, displacement, xxxx momentum xxxx force xxxxx

scalar - energy, work, speed, distance, temperature, mass, time (?)

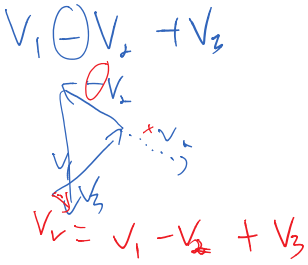
Adding vectors - draw them head to tail, then draw the resultant vector from the tail of the first vector to the head of the last vector.

$V_1 + V_2 + V_3$

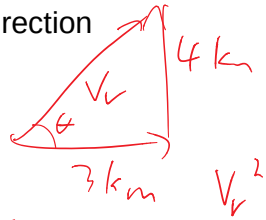


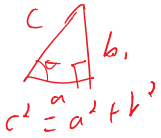
$V_r = V_1 + V_2 + V_3$

if you subtract a vector, just reverse the direction



eg. you walk 3.0 km East then 4.0 km North, what is your resulting displacement? - include magnitude and direction





$V_r^2 = 3^2 + 4^2$

$V_r = 5.0 \text{ km}$

$\theta = \tan^{-1} \frac{4}{3}$

$\theta = 53°$

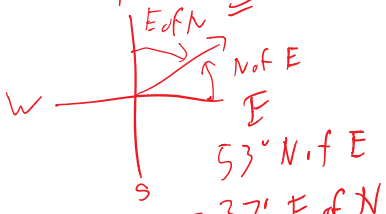
SOHCAHTOA

$\sin\theta = \frac{b}{c}$

$\cos\theta = \frac{a}{c}$

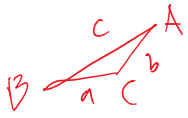
$\tan\theta = \frac{b}{a}$

displacement is 5.0 km 53° North of East.



What if it is not 90 degrees?
3 methods

1. scale diagram with a ruler and protractor.
2. cosine law and sine law

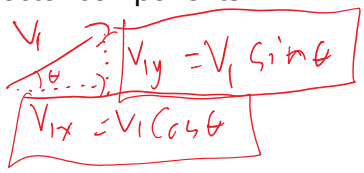


$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

$b^2 = a^2 + c^2 - 2ac\cos B$

3. Component method -
   Every vector can be represented as the sum of 2 perpendicular vectors called vector components.

the sum of 2 perpendicular vectors called vector components.

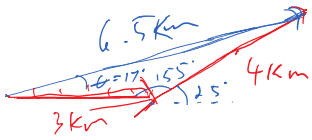


If you sum all the vector components of all the vectors, the result are the components of the resultant.

$$V_{rx} = V_{1x} + V_{2x} + V_{3x} \ldots$$
$$V_{ry} = V_{1y} + V_{2y} + V_{3y} \ldots$$
$$V_r = \sqrt{V_{rx}^2 + V_{ry}^2}$$

eg. You walk 3.0 km East then 4.0 km at 25.0 degrees North of East. Determine your resultant displacement using all 3 methods. Compare.

Scale 1cm = 0.5 km



cosine law

$d^2 = 4^2 + 3^2 - 2(3)(4)\cos(155°)$

$d = 6.8$ km

$\frac{\sin\theta}{4} = \frac{\sin 155°}{6.8}$

$\theta = 14°$

6.8km 14° North of East

Components

V_1 components $V_{1E} = 3$ km
$V_{1N} = 0$

V_2 components $V_{2E} = V\cos\theta$
$= 4\cos 25°$
$= 3.625$
$V_{2N} = V\sin\theta$
$= 4\sin 25°$
$= 1.690$

$V_{rE} = V_{1E} + V_{2E}$
$= 3.0$km $+ 3.625 = 6.625$km

$V_{rN} = 0 + 1.690 = 1.690$ km

$V_r = \sqrt{V_{rE}^2 + V_{rN}^2} = \sqrt{6.625^2 + 1.69^2}$

$= 6.8 \text{ km}$

$\theta = \tan^{-1}\frac{1.69}{6.625} = 14°$

p60-61,
q1, 5, 9, 11, 15, 17
read labbook investigation 3
method 2 p34-36